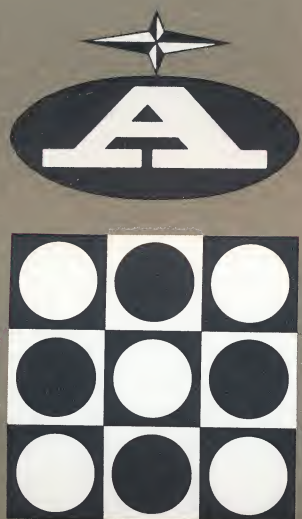




SYSTEMS

EXPERIENCE





It is our contention that a company's products are the best test of its ability to design, manufacture, and deliver. This section, therefore, summarizes the field-proven systems that have been designed, built, and shipped by ASTRODATA.

The equipment described in these pages has displayed excellent performance and reliability characteristics. Service-tested and proven, these systems are the products of extensive knowledge of and experience in solid-state analog and digital circuit design... they are the only valid evidence of our true technical ability.



THE COMPANY

Astrodata, Inc. began operation as a California corporation on July 1, 1961. A predecessor company, consisting of the same people and occupying the same facilities, had, however, been serving the West Coast aerospace electronics industry since the Fall of 1958. In the three years prior to forming Astrodata, the highly competent key members had succeeded in building — from virtually nothing — a sizeable organization doing a systems business of several million dollars annually.

The name Astrodata was chosen to reflect the branch of space age technology in which the company's personnel are now recognized as being most experienced and competent — instrumentation and control systems.

The continuous rapid growth of the company can be attributed to astute management and basic philosophies of sound business — building reliable equipment, delivering it on time, providing post-sales service and constantly advancing state-of-the-art. Numerous different systems, with a wide variety of end-uses, are presently operating reliably across the nation.

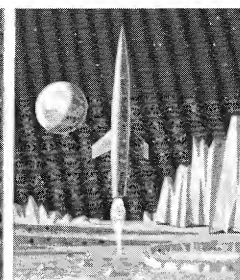
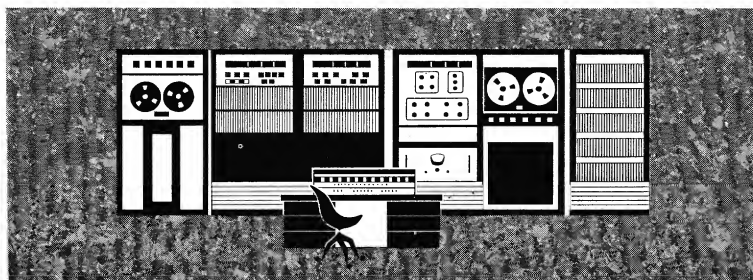
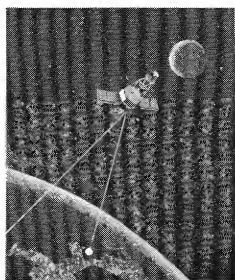
Significant factors contributing to Astrodata's con-

sistent, remarkable growth are: (a) the present management team has worked together for over 10 years, (b) the company has been able to attract and retain top technical talent, and (c) this technical competence has been combined effectively with aggressive marketing.

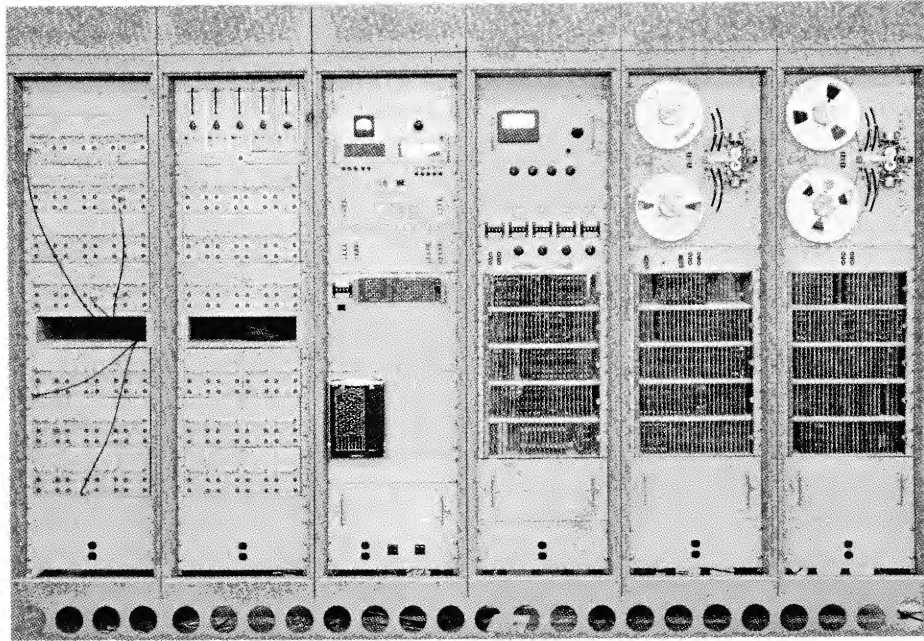
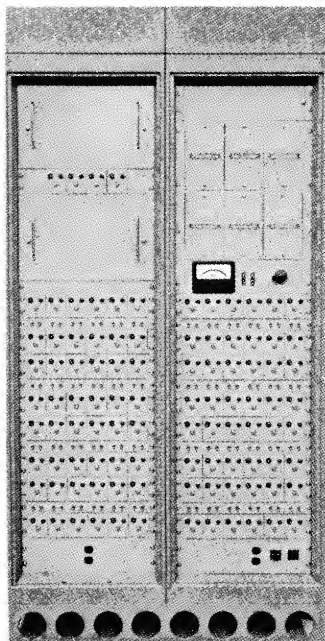
In Astrodata's first year of operation, over \$5 million worth of systems, timing equipment and standard instruments were shipped. At the conclusion of the second year, on June 30, 1963, this figure had risen to \$8.7 million. With the close of fiscal 1964, the third year's figures were over \$14 million.

In January 1963, Astrodata acquired Comcor, Inc., an electronics firm then located in Denver, Colorado. Comcor's entire operations were moved to Anaheim in July 1964. Comcor designs, manufactures and maintains analog computers and instrumentation.

Astrodata sells through a network of technically competent manufacturers' representatives, covering the entire United States and most countries of Western Europe. The company lists amongst its customers almost every major aerospace firm in the country, numerous universities and industrial concerns, both here and abroad.



ASTRODATA



STRUCTURAL TEST HIGH-SPEED DIGITAL DATA SYSTEM

This equipment, built for the Boeing Company, minimizes the delay between testing and release of data, effects data reduction economies and improves system accuracy. Principally, it acquires, edits and monitors data gathered during elevated temperature testing of aircraft and missile components.

The system receives signals from strain gages, thermocouples, resistance temperature gages, strain gage deflection indicators and load cells, as well as other transducers. Strain gage balance is automatic with provisions for "semi-automatic," "demand," and "manual" operation. Both manual and automatic calibration are provided for strain gage and thermocouple transducers. All data input signals are digitized as they are received.

Full-scale range may be selected. Timing signals are provided for recording on magnetic tape, strip charts and oscillographic records. Final data are recorded on mylar-based magnetic tape in a form compatible with the Remington-Rand 1103A computer.

Commutator, digitizer, recorder and control equipment operate at the rates of 200, 400 or 600 channels per second. The 200-channel input may be expanded to 400 or 600 channels.

Absolute system accuracy is 1%. Accuracy of the analog-to-digital conversion is $\pm 0.1\%$. Full-scale conversion is ± 999 decimal counts. The automatic sampling rate (200 data channels equals one cycle) is one, two, or three cycles per second.

THE DIGITAL SEISMOGRAPH SYSTEM

The ASTRODATA Model 7121 Digital Seismograph System acquires and records seismic data derived from analog sources. It multiplexes separate input channels and converts the analog inputs to straight binary-coded format. It then records, on punched paper tape, the digital data and the input channel and scan identification words. The recorded format is compatible with the input requirements of a Control Data Corporation general-purpose computer.

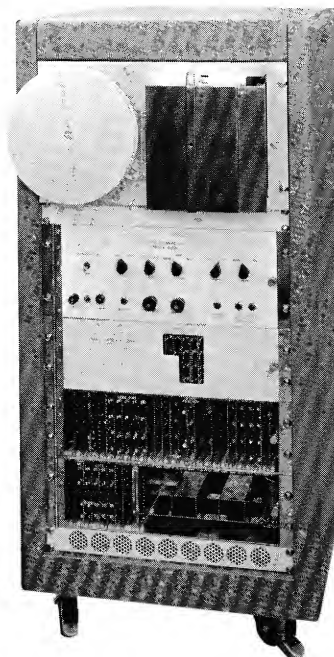
The crystal-controlled system clocks are furnished. A 96-kc oscillator permits 48 punching operations per second, with a scan rate of three readings per channel-per-second. A 64-kc oscillator allows 32 punching operations per second, with a scan rate of two readings per channel-per-second.

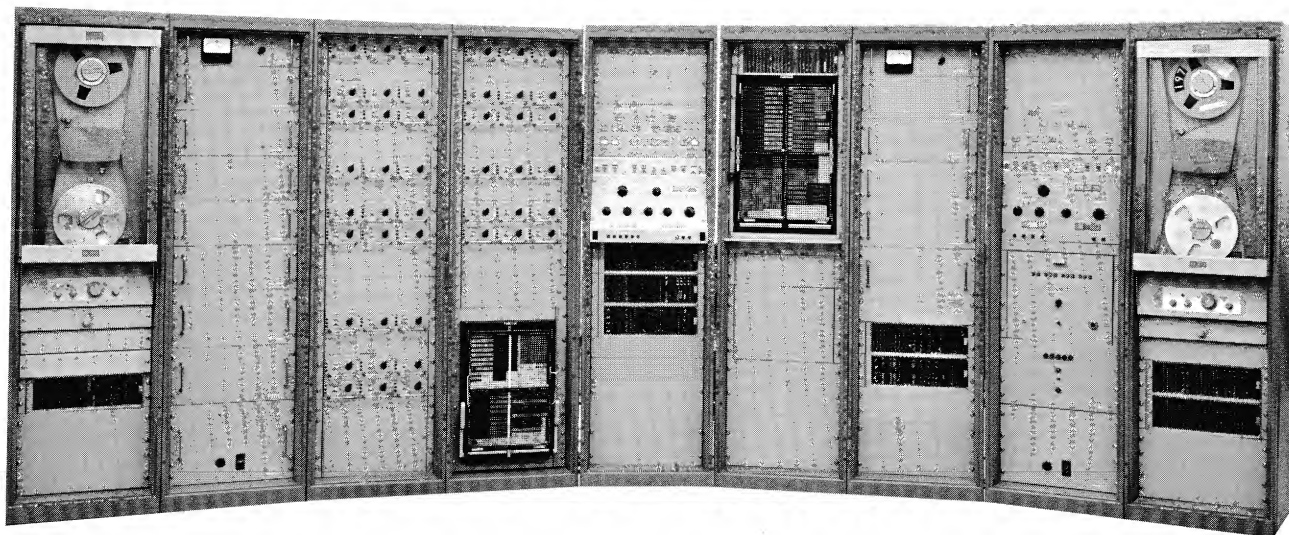
Punched-record length is 16 columns per scan and the scan-time counter capacity is 18 binary bits.

Three operating modes are provided: **Local**, in which the system operates independently of any other system; **Main**, in which the system serves as the main control for an auxiliary unit that is activated and controlled by the main system's timing and control logic; and **Auxiliary**, in which it serves as an auxiliary unit operating under the control of some other main system. In the **Local** and **Main** modes the system may be started either with an externally-applied pulse or by a front-panel pushbutton.

Three major functional units make up the system: ASTRODATA timing and control circuitry, a Tally Register Corporation Model 420 Tape Perforator and the ASTRODATA Model TB-1015B Analog-to-Digital Converter.

The Model TD-1015B is a medium-speed converter, ideal for use in multi-channel analog-to-digital conversion systems. Its conversion accuracy is $\pm 0.024\%$, $\pm$ one-half of the least significant bit. Full-scale input is nominally 0 to ± 9.9939 volts for a binary output of 0 to 16,383. Thus, the least significant bit represents 0.6103 millivolts. Resolution is one part in 16,384 at conversion rates of up to 1000 per second. The digital weight of the analog input voltage is determined by successive approximation and the resulting output is a 14-bit binary number that represents input voltage polarity and magnitude.





AUTOMATIC DATA-HANDLING SYSTEM

This control and acquisition equipment was designed for integration into a complete test program to permit the testing of various types of structures in accordance with prepared test routines. Digital techniques used provide automatic control of the test equipment that generates the dynamic inputs to the system under test. It records these dynamic inputs in digital code. It also records in digital code the test-specimen response to these stimuli. Two sections combine to supply the unusual flexibility of the system.

The Control Section accepts digital data from magnetic tape and translates it to analog voltages. The tape is prepared on an IBM 709 or 7090 EDPM computer. Forty-five independent, bipolar, analog-to-digital converters and associated digital storage registers are included. The maximum information

rate is 22,000 complete DAC changes per second. The analog voltages then control the application of the desired parameters to the test specimen. Control voltage amplitude accuracy is within $0.1\% \pm 5$ millivolts of the value demanded by the control tape. The frequency accuracy of the digital-to-analog conversion is 1%.

The Record Section accepts the inputs to the system under test as well as its corresponding analog responses. A high-speed electronic multiplexer or data scanner accepts data from 70 different sources. Analog responses are converted back to digital code and recorded on magnetic tape in a format compatible with an IBM 7090 computer. Response data recorded on the tape is accurate to within 0.1% of full-scale voltage, $\pm$ one-half the least significant digit. Measurements are made at a maximum rate of 22,000 per second.

TIMING OPERATIONS CENTER

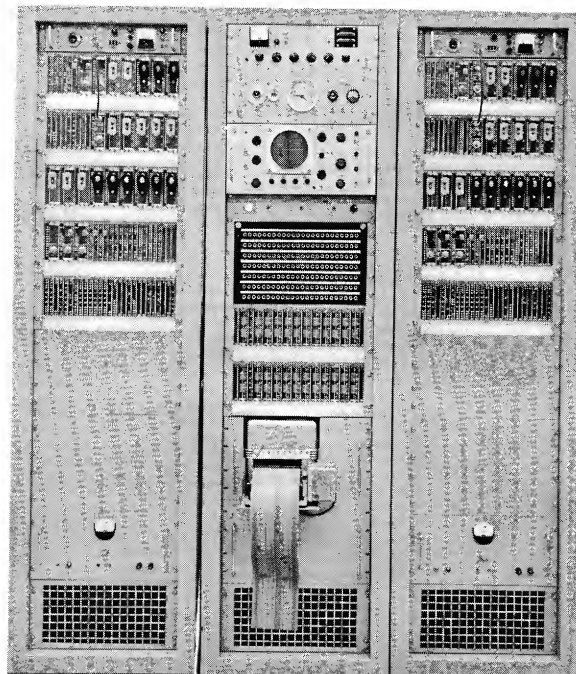
Fifteen Timing Operations Centers were designed and built for the U. S. Navy's Pacific Missile Range.

Each three-rack Timing Operations Center generates a series of individual, identifiable groups of electrical impulses, held to extremely close time relationship. These pulses are used to correlate telemetry data transmitted to and received from weapons systems, a satellite or space vehicle. Each Timing Operations Center consists of two identical, but completely independent time signal generators, each supplied from separate but identical precision frequency standards and powered by independent power supplies. The system is suitable for shipboard, fixed shore, mobile land, or aircraft installation.

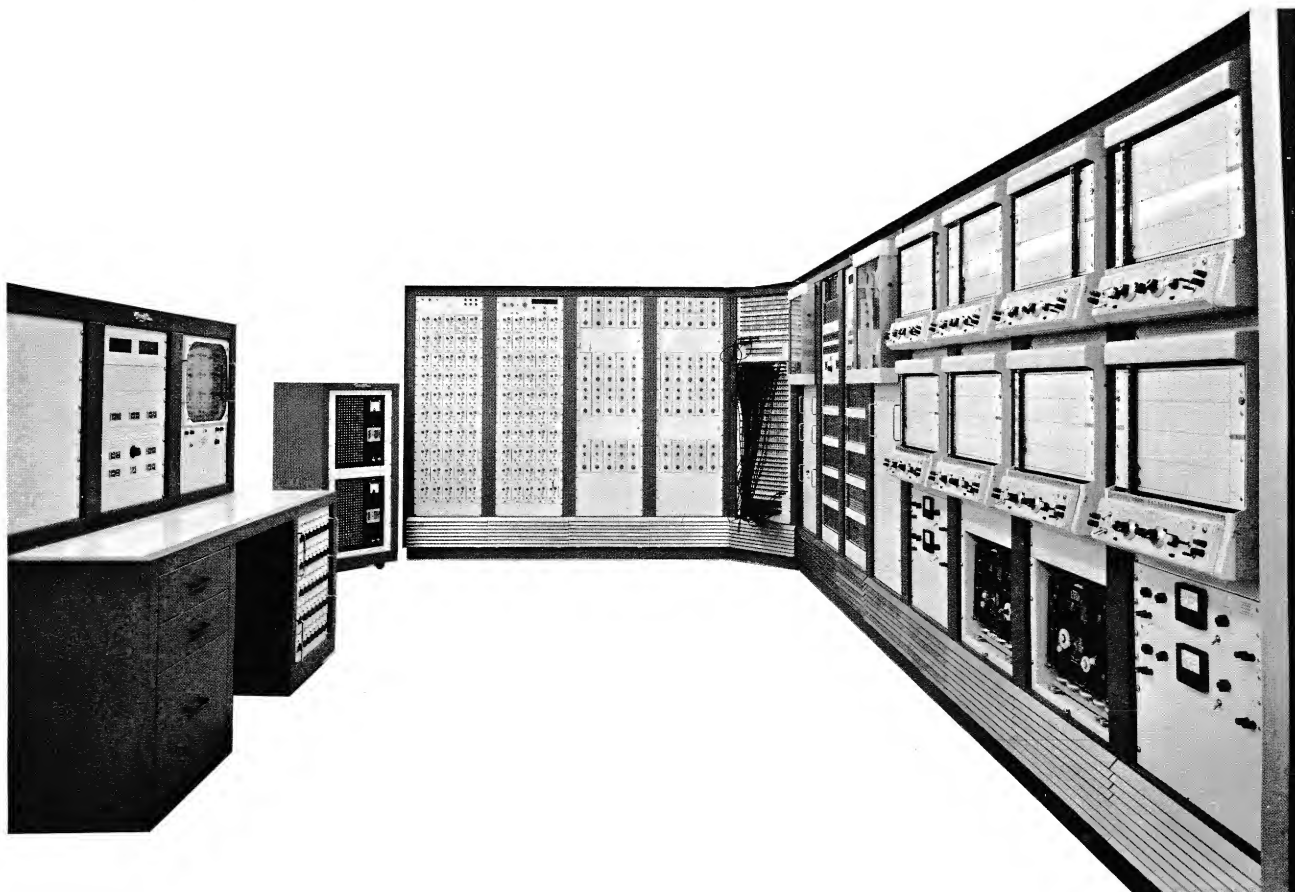
The timing equipment consists of modular, transistorized, plug-in building blocks which are in turn housed by enclosed relay-rack type cabinets. Built-in test and self-checking features are provided in order to simplify service and preventive maintenance features. With the exception of support test equipment, the Timing Operations Center is entirely solid-state.

Each timing system consists of a precision frequency standard, the output of which is 100-kc per-second. The 100-kc output is accepted by the timing signal generator and divided down to one-pulse-per-second by digital divider units. The 1-pps signal is accumulated in a binary-coded decimal format by a counter-type register. The register is permuted to read-out in terms of hours, minutes and seconds. Provision is made for automatic recycle after 23 hours, 59 minutes, 59 seconds. The contents of this time accumulator register are displayed on the front panel by means of in-line indicators. Provision is made to stop, preset and start the register, as well as advance or retard (in 10-microsecond steps) the rate of time accumulation.

The timing equipment is capable of generating eleven separate timing signals, any one of which may be delivered to any of 36 users from line-driver amplifiers. The signals are supplied to nominal 600-ohm balanced wire lines at any level between minus 20 dbm and plus 12 dbm rms (nominal zero dbm). These signals may also be broadcast on radio circuits. Six additional binary outputs are available in parallel form for distribution as dc voltage levels on 100-ohm unbalanced lines.



ASTRODATA



AUTOMATIC HIGH-SPEED DIGITAL DATA ACQUISITION AND PROCESSING SYSTEM

This system, designed and constructed for Lockheed Aircraft Corporation Missiles and Space Division, affords the maximum possible accuracy and reliability provided by the state of the art. Various information signals are recorded in either digital or analog form. Two hundred channels of information from any of three sources are handled by this system. These sources are strain gage bridge signals, thermocouple signals and miscellaneous millivolt signals. The system will patch any combination of these three types of signals up to a maximum of 100 channels for any one type of signal. Provisions are included for the simultaneous and parallel analog recording of two 14-track magnetic tape recorders and two 50-channel recording oscillographs. In addition, there is a bar-graph type presentation on an oscilloscope for quick-look purposes. Accuracy of the digital recording system is $\pm 0.1\%$ of full scale $\pm \frac{1}{2}$ least significant digit. This system will record up to 10,000 samples-per-second on magnetic tape.

Editing facilities are provided to transcribe the initial magnetic tape recording into a format acceptable to either the IBM 704 or 709 computer. These editing facilities enable all or any section of the initially recorded magnetic tape to be transcribed into computer format or presented on the analog plotters. This editing process in no way damages the original tape. The multiplexer used in this system is a high-speed switching commutator consisting of individual chopper-type relays for each input channel. The switches connect one input channel at a time to the system's low-level amplifier. Output from the amplifiers is commutated to the analog-to-digital converter by transistor switches.

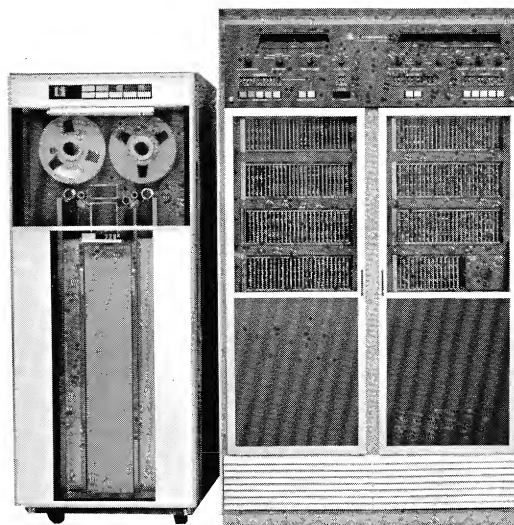
The buffer Register, a 16-bit storage register, stores each digital reading and transfers it to magnetic tape. The Buffer Register has two modes of operation. Initially, it accepts parallel information from the digital multiplexer and transfers it to the Raw Data Tape Recorder. Secondly, it receives information from the Raw Data Tape Recorder and transfers this information, four bits at a time, to the Computer Tape Recorder.

HIGH-SPEED TELEMETRY DATA REDUCTION SYSTEM

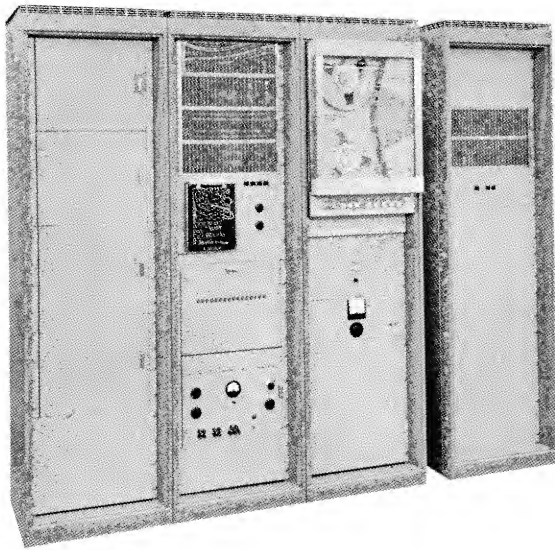
This system accurately prepares computer-compatible digital tapes from analog telemetry tapes. All data manipulations are very rigorously controlled. This equipment features:

1. A Universal time code translation system.
2. Fully automatic tape search and control operation.
3. Extremely versatile computer tape formatting.
4. Extensive built-in confidence testing.
5. Design for growth distribution center.

The analog-to-digital converter used in this system is the ASTRODATA Model TD-1003. This unit incorporates a sample-and-hold circuit with a sampling aperture of less than one microsecond. Digital output is in the form of polarity plus three decimal digits. Digitizing rate is 2.2 microseconds per decision. Recorded data may be accompanied with range time annotations to microsecond resolution. A built-in .01% calibration reference combined with an adjustable digital comparator provides extensive self-test capabilities.



ASTRODATA



THE 30-CHANNEL DIGITAL DATA RECORDING SYSTEM

This ultra-stable, highly precise (0.02% relative) data acquisition and recording system was designed by ASTRODATA for the Bell Telephone Laboratories to be used at the Western Electric Company facilities on the White Sands Missile Range. It is a multi-channel device designed to convert analog functions into binary-coded decimal values. These values are then recorded on a magnetic tape in a format compatible with IBM 704 series electronic data processing machines. Complete error-checking facilities are provided to check the data instrumentation system and the magnetic tape it produces. The system accepts 30 analog functions and two time inputs and processes them at a rate of 10 samples per-channel-per-second. This sampling rate can be increased on any channel or channels in ten-sample-per-second increments until a maximum system rate of 1,000 samples per second is obtained.

This system has a resolution of 15 binary digits: a sign bit plus 14 bits for the measured signals, which represents 32,768 bits full scale. The input signals are derived from a special-purpose, extremely precise analog computer that is used to process data originating in a high precision tracking radar. The original specification called for a conversion accuracy of $\pm 0.1\%$ full scale; the Acceptance Tests showed a conversion accuracy of $\pm 0.006\%$ of full scale.

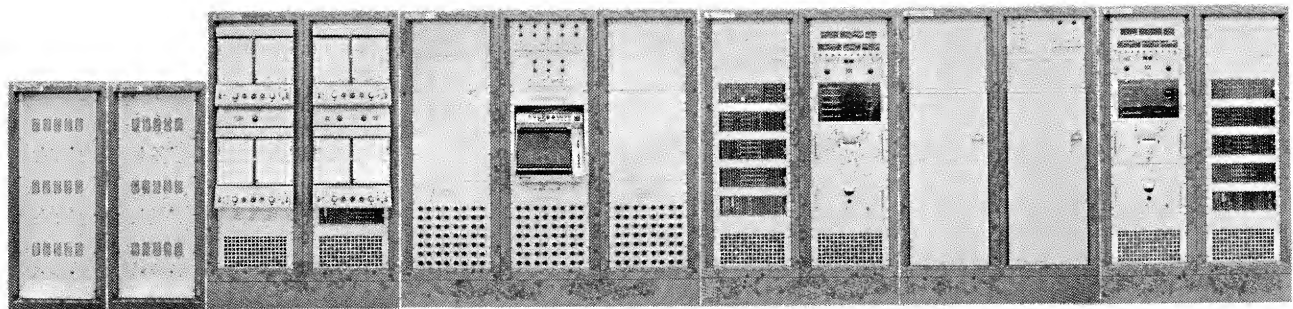
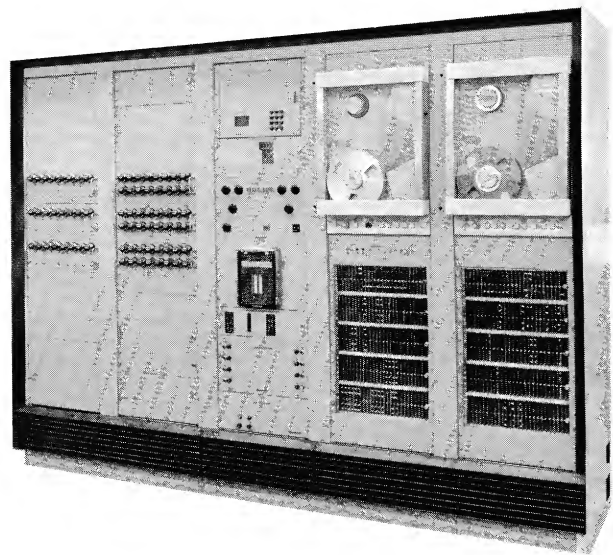
ANALOG-TO-DIGITAL DATA HANDLING SYSTEM

This system is designed to acquire, condition, process, store and read out data that originates from tests conducted on missile components, assemblies and systems. It consists entirely of solid-state components with the exception of a minimum required number of vacuum tubes in the sample-and-hold circuitry and in the tape transport. Forty-eight channels of simultaneously generated high-level voltage (analog data) signals can be commutated. These signals are converted from the analog to the digital domain at high sampling rates. In addition, a time channel and a reference voltage channel are commutated. The analog-to-digital converter will handle up to 10,000 samples in one second. Data is recorded on an AMPEX FR-400 tape recorder called the storage or memory unit.

Data from the memory tape unit is played back into the file-tape unit (another AMPEX FR-400) to produce a gapped tape, the format of which is compatible and optimum for entry into an IBM 704 computer.

Any two channels of data may be selected from the magnetic tape recorder on either the memory or file-tape unit. These channels are converted back into the analog realm by a two-channel digital-to-analog converter. The analog signals may be displayed on a X-Y plotter or a two-pen recorder. They are also available for direct measurement as a check of the system. Any two of the digitized channels can be selected for conversion and plotting.

The system may be readily expanded to handle 100 channels. Additional space has been allowed in the cabinet and the original component arrangement is such that expansion can easily be accomplished in the field. The absolute over-all accuracy of the analog-to-digital conversion system is $\pm 0.1\%$ of full scale; $\pm 1/2$ count of the least significant digit. This precision is maintained for all specified sampling rates up to and including 10,000 samples-per-second.



THE LOW-SPEED DATA RECORDING AND PLOTTING SYSTEM

The Low-Speed Data Recording and Plotting System was designed and fabricated by ASTRODATA for the Missiles and Space Division of Lockheed Aircraft Corporation. The function of this system is to record data received from copper-constantan thermocouples or from other transducers that provide low-level dc millivolt signals.

The system consists of an analog input section, a digital data recording section, a plotting section and an analog recording section.

The analog input section is capable of receiving the input signals of 500 channels. These signals are routed through the analog input section to the digital data recording section and/or the analog recording section. The digital data recording section converts the analog information into digital form, whereupon it is recorded on punched cards and on paper tape. The

data recorded on the punched cards can be sorted and submitted to the plotting section. The analog recording section, using strip-chart recorders, monitors selected channels.

Both the signal and the return wiring of all analog voltages are shielded from the rest of the system, ensuring a high degree of isolation between the analog wiring and the rest of the equipment. This condition reduces the effect of common-mode voltage.

The system achieved a common-mode voltage-rejection ratio that exceeds 143-db at 60 cps and 169-db at dc.

The system features a digital linearizer — a device that converts the millivolt output copper-constantan thermocouples into degrees Fahrenheit. The conversion accuracy of this operation is ± 3 microvolts from 300°F to 400°F.



ON-LINE COMPUTER REDUCTION OF TELEMETRY DATA

This telemetry system was developed by ASTRODATA, Incorporated for the U. S. Air Force. It utilizes an on-line, general-purpose, digital computer to decommutate and record telemetry data.

The system recognizes the various telemetry signal formats and processes these signals into conventional computer-compatible magnetic tape format. This tape may then be processed by normal digital computer routines to present the information in engineering units.

All rule-obeying functions are relegated to an on-line digital computer. Only such minimum peripheral equipment as will allow the computer to reduce and process data properly is included. Logic to determine format, synchronization, valid data, etc. is redundant in the presence of an on-line computer, therefore such equipment is not included in the system.

The system will process FM/FM, PAM and PDM data.

PAM pulse rates from 50 pps to 5000 pps and PDM pulse rates from 50 pps to 1000 pps can be handled.

Reduction of the above types of telemetry data requires only that the time

of occurrence and magnitude of the signal segments be noted. From these two facts the digital computer automatically determines format, synchronization, pulse rate, data value, and validity of signals.

The following table relates the type of time of occurrence and magnitude data sent to the computer for the various telemetry signals.

Telemetry Signal	Time of Occurrence	Magnitude
FM (analog)	digitizing rate	amplitude
PAM	start of pulse	amplitude
PDM	start of pulse	pulse duration

The time of occurrence and magnitude signals are written on a gapped-format intermediate magnetic tape through the digital computer's core storage and tape write circuits. This intermediate tape is then processed by the computer during a second pass. The data output presentation can be in some conventional form such as listings or plots of the reduced data. Digital-to-analog converters are provided for plotting analyzed data. Computer-compatible tape suitable for further computer analysis and processing is also prepared.

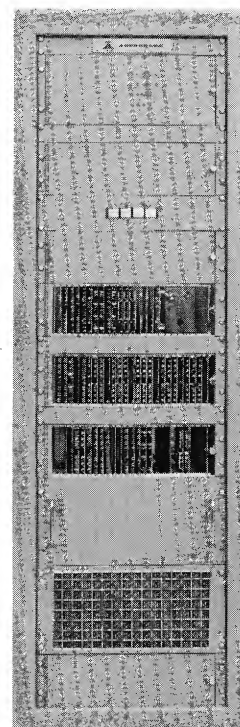
REVERSIBLE ANALOG/DIGITAL CONVERSION SYSTEM

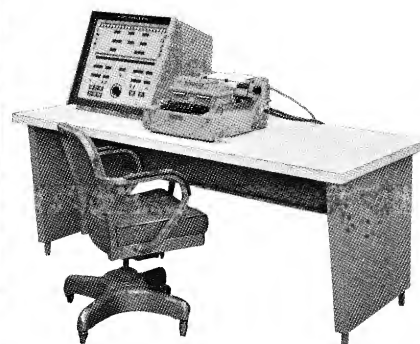
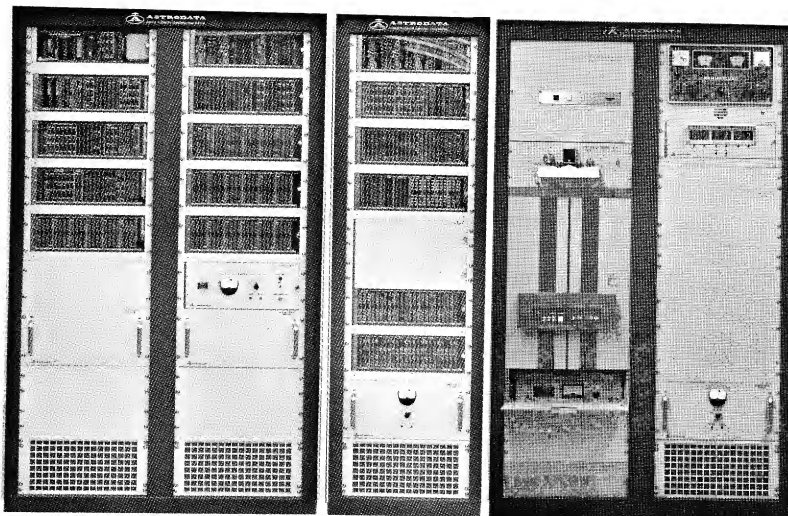
This system, designed and manufactured by ASTRODATA for Bell Telephone Laboratories, is a multi-channel device designed for analog-to-digital and digital-to-analog data conversion. It will:

1. Convert analog voltage position data from NIKE HERCULES antenna mounts to digital form for entry into a digital computer.
2. Convert digital computer output data to analog voltage form to drive plotting boards and a recorder.
3. Convert digital computer output data to analog voltage form to control antenna mount servo motors for slaved operation.

Complete error-checking facilities are included for checking the conversion accuracy of the data system. Analog inputs are converted to digital outputs and digital inputs are converted to analog outputs simultaneously during each cycle. The data are presented in parallel form to the input circuits of the digital computer. Six of the analog input channels have a range of ± 100 volts, and seven of them have a range of ± 1 volt.

The analog-to-digital converter used in this system is a medium speed ADC with a conversion accuracy of $\pm 0.01\%$, $\pm$ one-half the least significant digit. This ADC determines the digital weight of the analog input voltage by a method of successive approximations. The resulting output is a 15-bit binary number representing input voltage polarity and magnitude. Full-scale input is nominally zero to ± 10 volts for a binary output of zero to 16,383.





REMOTE TELESCOPE COMMUNICATION AND CONTROL SYSTEM

The Remote Telescope Communication and Control System communicates with and controls a remotely-located telescope. An on-line, general purpose, digital computer is an integral part of the system. The system equipment at the Telescope Site automatically accepts analog and digital data from the telescope, digitizes the analog inputs, transmits a Barker Word for synchronization purposes, performs a longitudinal parity check on the resulting data, and delivers it to the system equipment at the Control Center in a bi-phase modulated, 1024-cps carrier form. Thirty channels of telescope-response information are multiplexed into an 11-bit straight binary analog-to-digital converter and the digitized data is transmitted, one bit at a time, to the Control Center. Data is recovered at the Control Center with a high degree of accuracy even under severe noise-to-signal ratios. The recovered data, the time-of-day from a sidereal clock, and any manual commands entered at the Control Console by the operator are delivered automatically to the computer.

The computer (a Packard Bell PB250) communicates with the Control Center, asynchronously, through a 22-bit high-speed buffer register. Information is sent out through this register for transmission to the Telescope Site and for display on the Control Console. Upon command from the computer, the high-speed buffer register accepts parallel, binary, information from the Control Center equipment. The computer then decodes this information and makes a continuous visual display at the console of the Right Ascension, Declination, Zenith Distance and Azimuth of the telescope.

The status of the Shutter, Dome, Registers and Encoders is displayed at the Control Console as well as digital or "go/no-go" information that the operator has programmed and patched to the unassigned displays on the con-

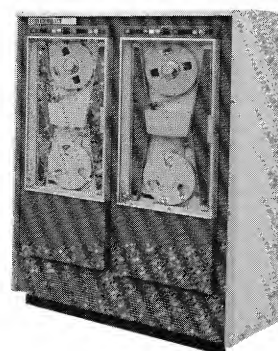
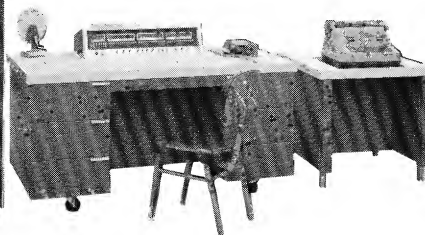
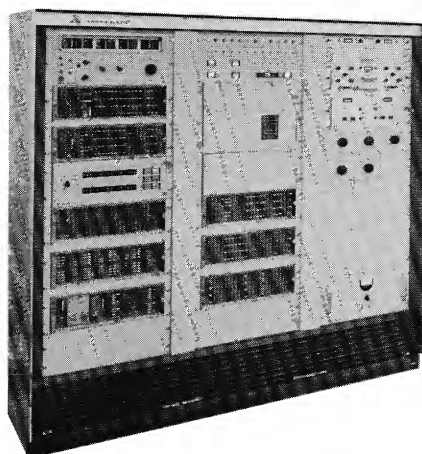
sole. Provisions are also made on the console for 100 pre-programmed sub-routines to be carried out by the computer upon manual command.

The aforementioned displays on the console are all driven from decoders that operate, through a patchboard, from seven of the output registers. The computer loads these registers from decoded data that was generated at a patchboard.

Manual remote control also originates at the Control Console. Changes in telescope position can be entered via a telephone dial. The operator selects the type of change desired (plus or minus, declination or right ascension) and dials four digits. These are entered into a register and simultaneously displayed.

A longitudinal parity check is made upon the incoming data for indication of validity. The Control Center then transmits a 512-cps, bi-phase-modulated signal back to the Telescope Site. This signal contains a longitudinal parity bit, a Barker Word configuration (for synchronizing purposes) and computer-generated data words to be used for control of the telescope.

The same data transmission and data recovery methods are used in going from the Control Center to the Telescope Site as are used when the flow of data is in the opposite direction. The synchronization and data recovery logic at the Telescope Site recover the data, shift it in serial fashion through a 32-bit data shift register and store it in sixteen 32-bit output storage registers, under control of a patchboard. The outputs of the sixteen storage registers are available at the rear of the cabinets for driving digital positional motors. These motors are automatically put in "stand-by" when the computer is operated off-line, so as to discontinue movement of the telescope.



COMPUTER-CONTROLLED TELEMETRY SYSTEM

Data from FM telemetry tapes is decommutated, sequentially sampled, converted to digital form and applied on-line to a Control Data Corporation 160A Digital Computer.

An ASTRODATA Tape Search and Control System allows selection of a pre-determined portion of telemetry tape for processing, while an associated time code translator converts the range timing signal to computer-acceptable

form and interlaces the time with multiplexed data. Plug-in code modules allow operation with various range code formats.

Digital to analog converters present select channels of data to a strip chart recorder either "on-line," or from the computer.

A wide variety of tape formatting is possible by cooperative use of the computer and data acquisition sections of the system.

CALIBRATION AND CONDITIONING SYSTEM

This Calibration and Conditioning System is a highly versatile system embodying a new and important concept in the utilization of transducer signals. It can accept inputs from virtually any transducer and match the source impedance; supply transducer excitation; provide system calibration; switch either by remote or local command, between calibrating voltage and signal voltage, and condition either signal to one standard span. In short, its functions are: excitation, calibration and normalization. These functions may be accomplished by this integrated piece of equipment accurately, reliably and with great ease of operation.

Each calibration and conditioning unit measures only 20½ inches in depth, is 5¼ inches high and 9½ inches wide. It occupies far less space than conventional equipment normally required to perform such varied functions. Duplicate power supplies, voltage references, enclosures and controls are obviated. Use of standard etched circuit cards as basic building blocks reduces manufacturing cost, without impairing reliability.

Each channel is made up of connected sub-units. These sub-units are extremely versatile modules consisting of ASTRODATA etched-circuit cards. The cards can be easily interconnected to act as narrow-band amplifiers, wide-band dc amplifiers, demodulators, frequency-to-dc converters or precision attenuators.

Sub-Unit Functions

a. Source Matching

Source-matching cards enable the sub-unit's circuitry to be matched to virtually any available transducer, such as a tachometer, strain gage, thermocouple, pressure transducer or fire detection device. By simply changing a card or two, inputs ranging from 10 millivolts to 5 volts can be accepted. Since the input impedance of the channel cards exceed 5 megohms, there is practically no loading on the input transducer.

b. Excitation

The excitation sub-unit supplies the needed voltages, of proper magnitude and precision, for use by the calibration sub-unit and the external transducers. A 0.01% precision voltage source for strain gages is available within each channel.

c. Calibration

The calibration sub-unit takes the precision voltages offered by the excitation sub-unit and generates precision steps of voltage. These steps represent known portions of the full-scale output of the transducer being utilized. Regardless of the amplifier gain selected, the calibrator generates a precision voltage which tests the system at the 0%, 25%, 50%, 75% and 100% points.

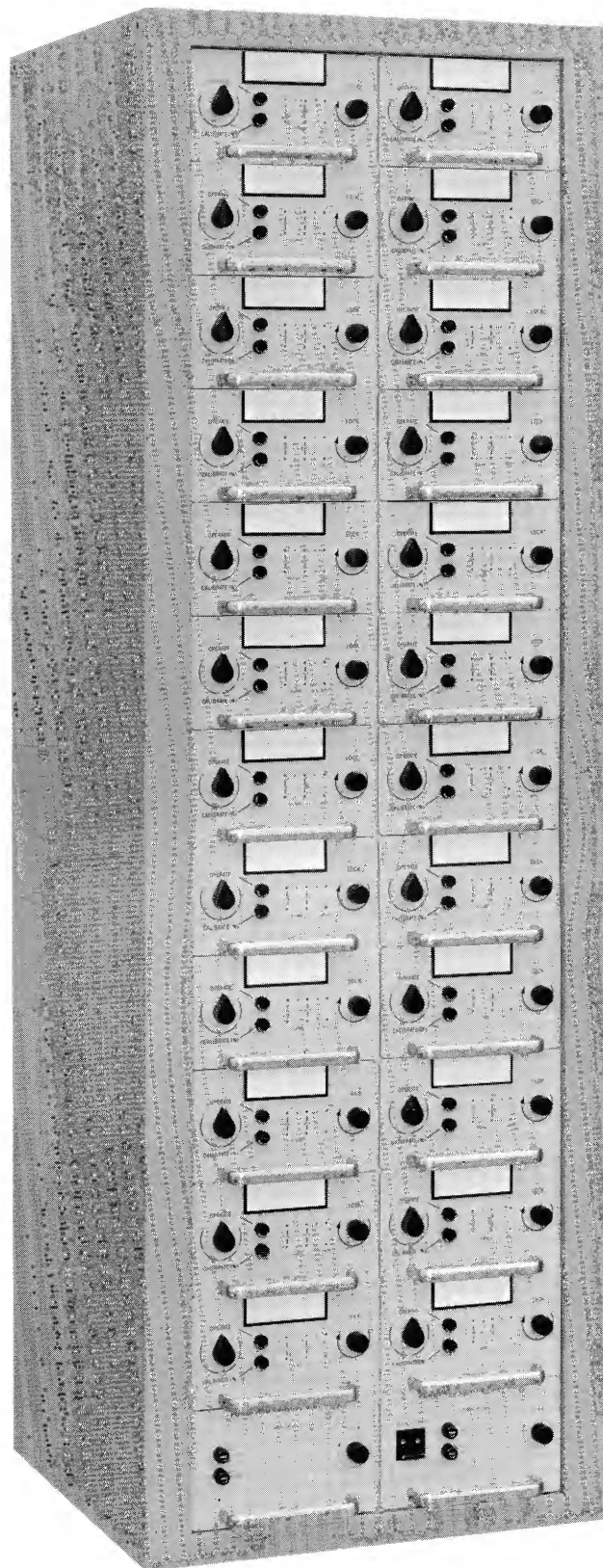
d. Conditioning

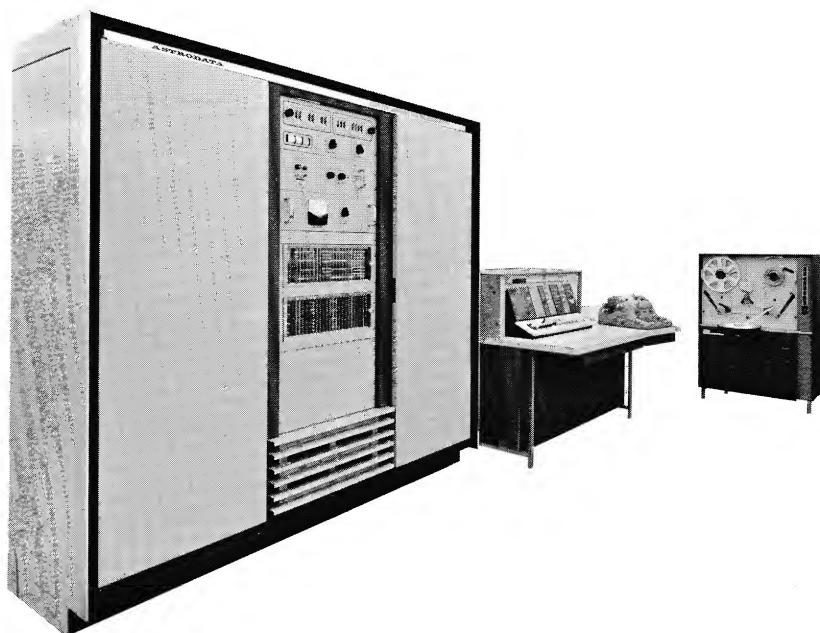
The conditioning sub-unit is used to normalize the type and range of signal from a particular source by performing in any of three general ways: (1) it may amplify a dc or ac signal, (2) it may convert an unknown ac signal to the proportional dc output, (3) it may convert to a normalized dc signal an unknown frequency introduced to it.

e. Switching

The switching sub-unit connects either the transducer signal or the calibration signal to the conditioning sub-unit, on local or remote command.

If instrumentation needs change, or if entirely new needs arise, the user of this equipment may profit further from ASTRODATA's advanced design. By acquiring only those few circuit cards comprising the new sub-unit he may use the same basic Calibration and Conditioning System without fear of obsolescence.





COMPUTER-CONTROLLED DATA ACQUISITION SYSTEM

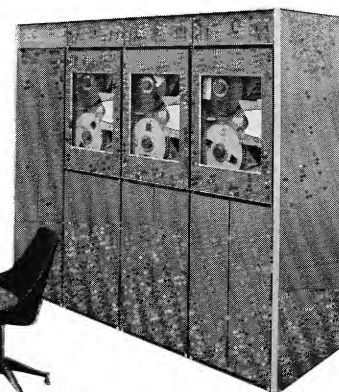
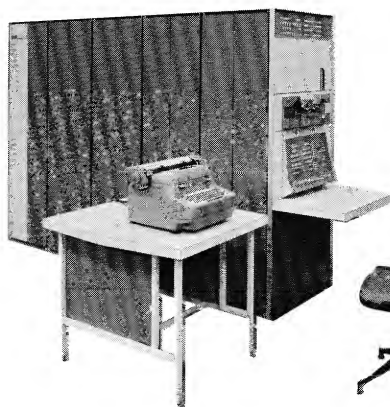
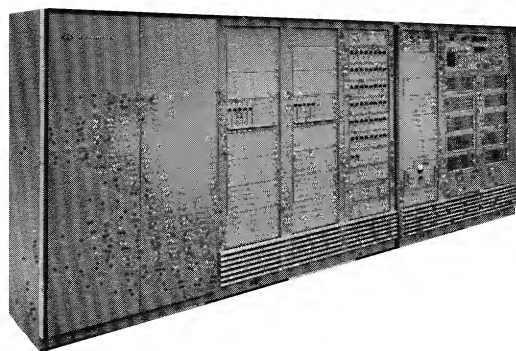
This Computer-Controlled Data Acquisition System scans up to 1,000 input channels and provides a print-out, in true engineering units, of information such as Young's Modulus of Elasticity, the maximum and minimum normal stresses, maximum shearing stress, the stress angle from strain gauge rosette, temperatures, deflections, etc. The system is currently being used in the design of heat exchanger chambers for submarine nuclear reactors.

Using a single strain gauge power supply, electronic balance potentiometer and calibration resistors, the system scans all strain gauge input channels and stores, in an IBM 1620 Computer, the digitized value in the form of a balance index. Upon command for a data scan, either by the manual control

panel or the computer, the system selects the desired input channel via a multiplexer address, electronically balances, then measures and stores the data value in the digital computer. Sequencing of the multiplexer can be completely random.

Multiple thermocouple channels are signal-conditioned by a cold junction compensation network.

Computer interrogation of a time-of-day clock for a predetermined value allows the system to scan the data and perform computation at prescribed intervals.



COMPUTER-CONTROLLED WIND TUNNEL FACILITY DATA SYSTEM

Basically, the Wind Tunnel Facility Data System consists of a central data acquisition system that operates under complete computer control. The on-line, general-purpose digital computer controls the rate at which data is acquired and selects from the 240 input channels the channels whose data is to be processed.

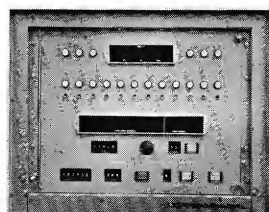
Each remote wind tunnel site has a comprehensive control and readout console. This enables the operator at the remote site to request servicing

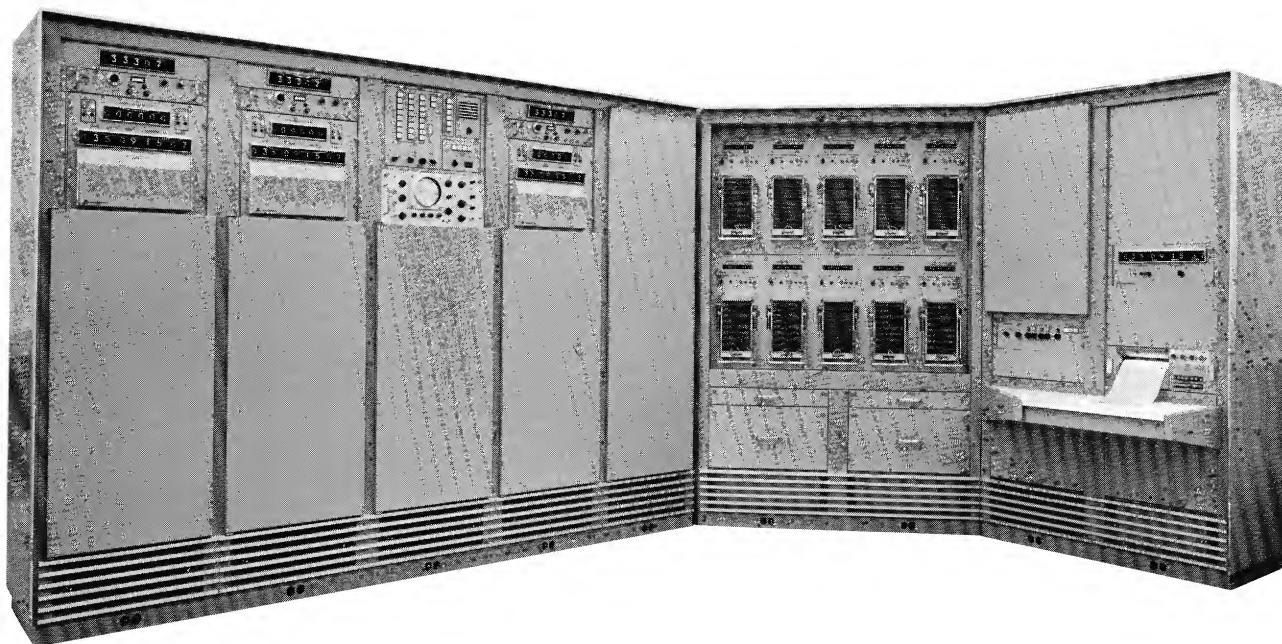
from the central system and to control the acquisition of data that originates at his site. Signal conditioning equipment and a digital output recorder are also installed at each site.

The operator at the remote wind tunnel site may request a particular type of data acquisition run. The digital computer honors the request in accordance with the priority assigned to the originating site. When the request is honored, the digital computer loads the appropriate program from a master program tape. The computer program then organizes the central system as required to execute the particular program.

Data is acquired and recorded on the computer's output magnetic tapes. The digitized output may be directed back to the originating site for recording in engineering units.

Performance tests for this system demonstrated that the total uncertainty for the system with 2.5-millivolt full-scale signals is less than 1.25 microvolts, or 0.05 percent of full scale (3 sigma). To the best of our knowledge, this is the most accurate low-level data system ever built.





CENTRAL RANGE TIMING SYSTEM

This Time Signal Generation System was designed and built by ASTRODATA, Inc. for the White Sands Missile Range. The system generates various time codes in pulse form. These codes are transmitted to remote missile range points over a UHF radio link. The codes are used to correlate telemetry, optical, radar and other data transmitted to and received from weapons systems, satellites or space vehicles.

The system contains three identical time code generators which generate specific time codes in serial, pulse-width, amplitude-modulated carrier and dc level-shift forms.

A transfer unit provides a means for the outputs of any one of the time code generators to be manually switched into use as the on-line generator. Coincidence-sensing circuits continuously monitor the outputs of the time code generators and activate visual and audio alarms when an

out-of-tolerance condition occurs. There is a provision for automatic transfer from the on-line time code generator to another time code generator if the on-line generator shows an out-of-tolerance condition when compared to the other two generators.

A control function programmer unit contains 10 identical patchboard circuits which determine when programmed control function data is to be introduced into the time code. The control function data may be introduced at a specifically chosen time-of-day or operation status condition, or from an external signal, or manually.

The 320-bit operation status storage register stores the operation status data from a unit external to the system. This data is used for generating the operation status serial code and is also used as the operation status coincidence data of the control function programmer unit.

GROUND COMMAND SUBSYSTEM

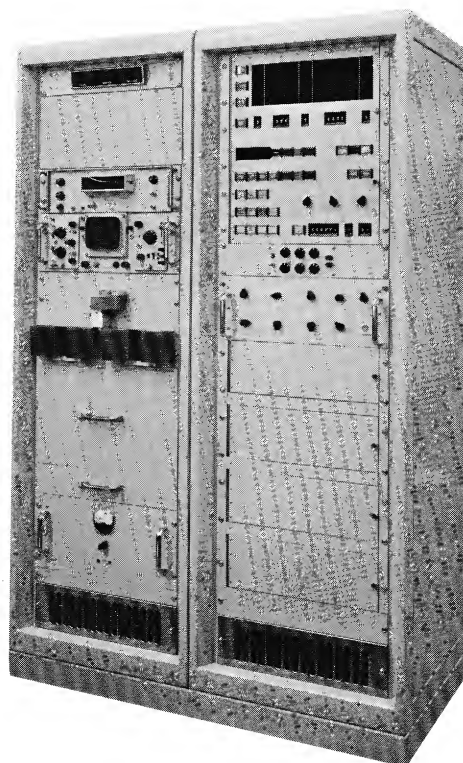
This Ground Command Subsystem was one of several designed and built for use in the Ranger, Mariner and other space programs. The primary functions of the subsystem are:

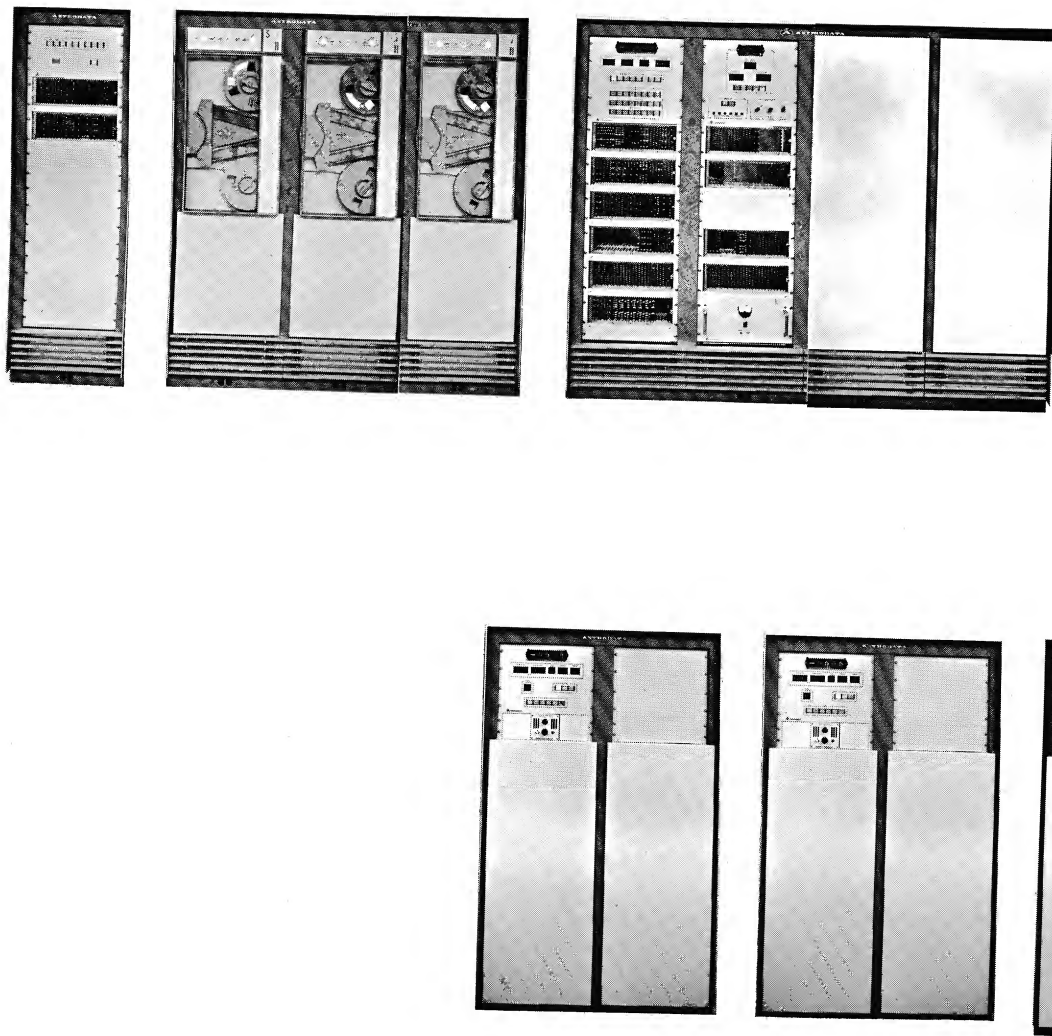
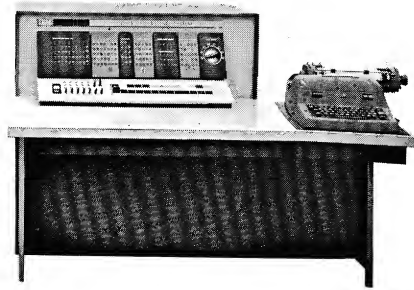
1. Verification of the accuracy of spacecraft command data as presented to the subsystem on punched paper tape.
2. Transmission of the command data to a transmitter modulator and the monitoring of the transmitted signal.

Auxiliary functions of the subsystem include the transmission of command data entered into the subsystem by means of manually-set switches, and the preparation of punched tapes for test or data transmission purposes from manually-set switch information.

Extensive data checking and operational self-check features are provided to ensure that accurate command data is transmitted.

The subsystem has marginal testing features which enable location of circuits that are gradually approaching a condition of possible failure. These circuits can be replaced during scheduled maintenance periods to ensure reliable system operation at the required command transmission times. Built-in test operating modes facilitate rapid location of actual circuit failures.





WIND TUNNEL COMPLEX DATA ACQUISITION SYSTEM

This Data Acquisition System was designed and built by ASTRODATA for a Wind Tunnel Complex. The system accepts analog signals from three wind tunnel sites. These signals are then conditioned, amplified, digitized and recorded on magnetic tape in a format suitable for entry into an IBM Digital Computer. Data may be acquired simultaneously from all three remote sites or from any combination thereof.

Each remote wind tunnel site is equipped with a control and signal-conditioning console. Since a separate magnetic tape recorder is also

associated with each tunnel, the operator at a remote site has immediate access to acquired data.

Besides presenting data to the magnetic tape recorders, the central data processing equipment can operate in real time with an on-line digital computer via an ASTRODATA-supplied input/output synchronizer. When the data acquisition is complete, the IBM 1620 Digital Computer can take control of the magnetic tape units and use them as conventional input/output equipment.

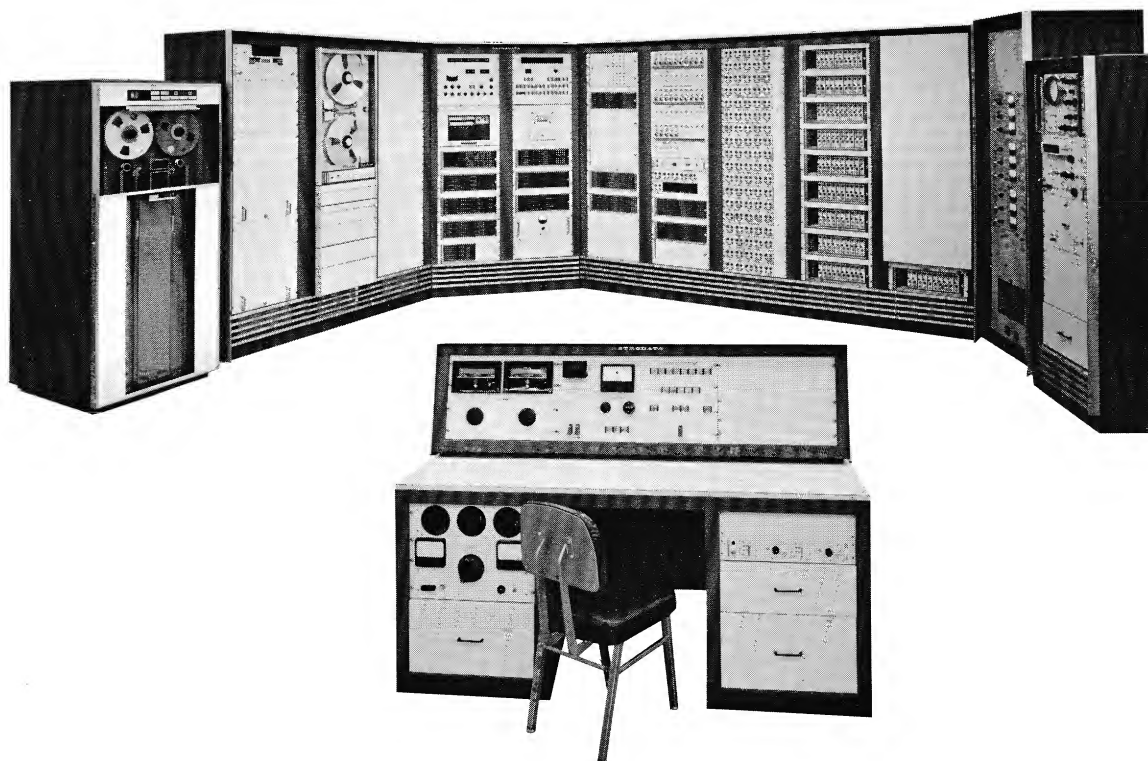
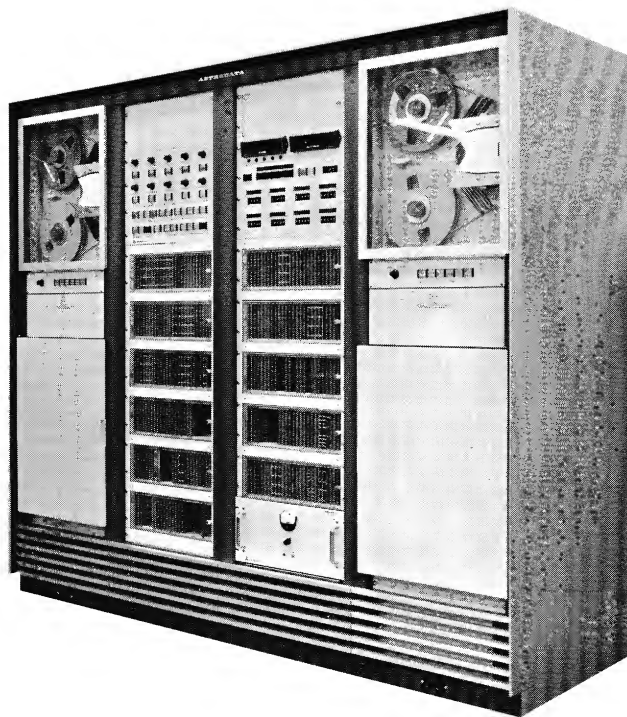
HIGH-SPEED DATA ACQUISITION SYSTEM (CENTRAL CONTROL UNIT)

This Central Control Unit is a key part of a High-Speed Data Acquisition System. The unit programs, receives, processes, records and displays information from as many as five remote test stands.

The unit is capable of receiving digital signals on as many as 1000 channels. The input signals are recorded in digital form in computer-acceptable format on IBM-compatible magnetic tape at a rate of 556 bits per inch. An input signal may be selected for digital display.

A patchboard is provided for setting up the programming sequence for channels that are in an alarmed condition. A total of 200 channels may be alarm-scanned, with an upper and lower limit for each channel.

All operating mode sequences, limiting sequence, recording rates, activations of test sites and readouts for the overall system are controlled and displayed on the unit control panel.

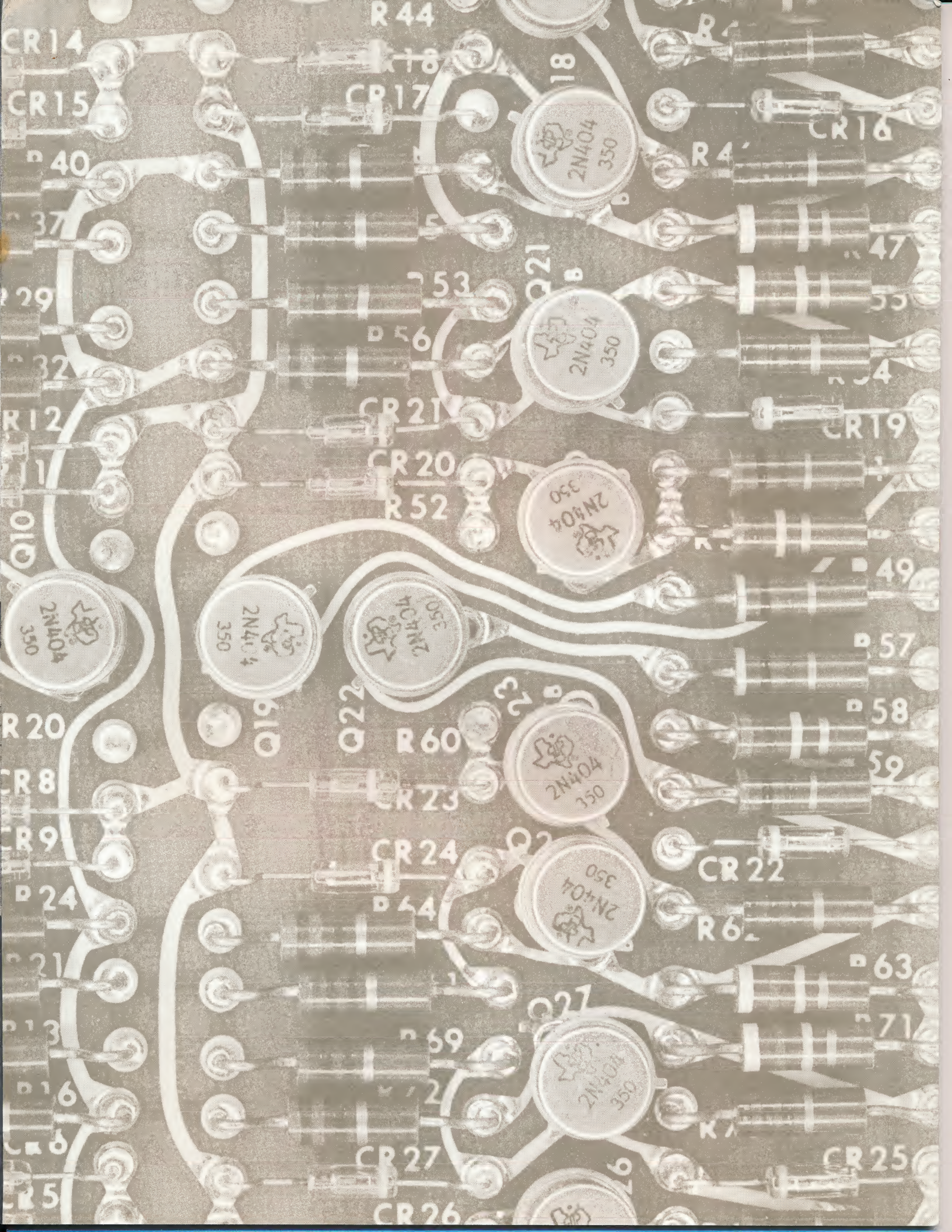


HIGH-SPEED DIGITAL DATA ACQUISITION SYSTEM

This High-Speed Digital Data Acquisition System receives analog data from any one of three rocket-engine firing bays. The system conditions, amplifies and digitizes this analog data and records the result on an IBM 729-IV digital tape recorder in a format suitable for entry into an IBM 1401 computer.

The system has a total input capability of 20 high-level and 80 low-level channels. The input data is processed at a rate of 15,000 channels per second. Provision is made for the selection of up to 100 analog input channels, as input to the digital tape recorder.

System output equipment includes an FM tape recorder, an analog oscillographic recorder, a digital printer and visual data displays.





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